REPORT OF PROCEEDINGS

Conference on Rice Research
Western Regional Research Laboratory

February 17, 1949

The purpose of this conference was to confer with representatives of the rice industry concerning the objectives and progress of the rice research program in the Bureau of Agricultural and Industrial Chemistry. Those attending included representatives of the RMA Rice Advisory Committee, millers, growers, vegetable oil processors, resin technologists, rice machinery manufacturers, consultants, the University of California College of Agriculture and Experiment Station, the technical press, and this and other Government bureaus.

This report summarizes the papers presented at the conference, and the pertinent points raised in discussion. If further details regarding a particular subject or problem are desired, correspondence should be directed to the persons concerned. A list of participants in the conference is appended.

Western Regional Research Laboratory
Bureau of Agricultural and Industrial Chemistry
Agricultural Research Administration
U. S. Department of Agriculture
Albany, California

P R O G R A M

Thursday, February 17, 1949

10:45 a.m.	OPENING REMARKS	Dr. M. J. Copley, Director Western Reg. Research Lab.
	Rice Research from the Grower's Viewpoint.	Mr. Glen Harris, Grower, Member, RMA Rice Advisory Committee.
	Rice Research from the Miller's Viewpoint.	Mr. Marshall E. Leahy, Exec. Sec., Farmers' Rice Growers Cooperative.
	Research on Utilization of Rice Byproducts.	Capt. A. B. Court, Consulting Engineer. Member, RMA Rice Advisory Committee.
12:30 p.m.	LUNCH AND GROUP PHOTOGRAPH	
1:30 p.m.	Rice Research Program of the Bureau of Agricultural and Industrial Chemistry:	
	Western Regional Research Laboratory.	Dr. E. B. Kester, Western Regional Research Laboratory.
	Southern Regional Research Laboratory.	Mr. R. O. Feuge, Southern Regional Research Laboratory.
	Utilization of Rice Hulls.	Dr. F. P. Griffiths, Western Regional Research Laboratory.
3:00 p.m.	Round Table Discussion	Dr. H. S. Olcott, Western Regional Research Laboratory, Moderator.

INTRODUCTORY REMARKS

by

M. J. Copley, Director, Western Regional Research Laboratory

Dr. Copley welcomed the guests and gave a brief history of the Regional Laboratories from the time they were authorized in 1938. He listed the commodities originally assigned to the Western Regional Research Laboratory, and explained that rice had been more recently added by virtue of funds made available under the Research and Marketing Act of 1946. As both the South and West were large producing areas for rice, research on this subject was placed under the aegis of both the Southern and Western Regional Laboratories. Each Laboratory was to work on different phases of the general program as outlined in RMA Project 21. Actual work was started here late in 1947.

In the interest of becoming better acquainted, the participants in the conference were asked to rise and introduce themselves.

RICE RESEARCH FROM THE GROWER'S VIEWPOINT

by

Glen Harris, Rice Grower, Member of RMA Rice Advisory Committee, and Official of Commodity Credit Corporation.

Mr. Harris grouped the research problems of the grower under three headings: 1. Production or on-the-farm problems. 2. Marketing problems. 3. Utilization research, new uses, etc.

1. Production or on-the-farm problems. He stated that the production problems had been and are receiving more attention than the others and, consequently, need comparatively less attention in any future program. However, he mentioned several items on which work should continue:

(a) Development of new varieties of rice such as those that give increased yields, types that are disease-resistant, or have better milling qualities, as well as those that mature early or late.

(b) Conservation of soil fertility by new rotation techniques, and better fertilizing programs. Weed control was also stressed.

(c) Rice drying and bulk storage, and, in particular, the need for fundamental data on the artificial drying of rice, temperatures to use, quantities of air, velocity of air stream, and design of equipment. Most of the rice drying in California is done by the farmer, and the major part of all drying is performed artificially.

2. Marketing Problems. Most of the rice problems arise after the rice is harvested. Present methods of grading rough rice leave much to be desired and should be revised. There is a need for expanded activity in the field of rice marketing. The fundamental problem is to persuade people to eat more

rice. This might be done by finding better methods of packaging and by development of a product which has a better flavor or cooking qualities than has been sold heretofore. Attempts should be made to find out what the consumer wants in the way of a bulk or packaged product.

3. Utilization research, new uses, etc. There should be increased emphasis on new uses for all parts of the rough rice. Industrial uses, such as starch or alcohol, for the grain itself should be explored. The utilization of rice hulls is a major problem and further work should be done along this line. Too much emphasis should not be placed on rice bran oil as bran represents only about 8 percent of the rough rice and the oil is only about 12 percent of the bran.

Discussion

In response to a question on the proportion of rough rice artificially dried in California, it was estimated that about 90 percent of the crop was thus treated. This is a somewhat higher figure than would hold in the South.

RICE RESEARCH FROM THE MILLER'S VIEWPOINT

by

Marshall E. Leahy, Executive Secretary of the Farmers' Rice Growers Cooperative Association, and Member of Rice Advisory Committee.

Mr. Leahy reviewed the objectives under RMA Project No. 21, and commented favorably on the importance of the work already underway on stabilization of brown rice and bran, and on rice hulls. He indicated that a study of these problems would establish facts of considerable value to the rice industry. The rice hull problem has been given top priority by the Rice Advisory Committee.

There are other matters, however, in which all rice millers are interested and which are encompassed in the project. Most noteworthy is the need for improvement in rice milling techniques, as the industry is steeped in tradition, and practices which have been accepted for generations as sacred, are no longer the best or most efficient. This type of investigation could well be performed by the Department of Agriculture. In the long run, it is better to finance research than to spend the same amount or more of money on subsidies for the farmer. The objectives in this research should be increased efficiency and economy of operations. The problem today is not lack of demand for rice, but rather lack of demand at a price people will pay, and our rice must compete with foreign rice in price and quality.

Mr. Leahy concluded his talk by stating that the opinions expressed were his own and did not necessarily reflect the opinions of the industry in general.

UTILIZATION OF RICE BYPRODUCTS

by

Captain A. B. Court, Consulting Engineer

Rice byproducts were defined as secondary, incidental but unavoidable materi obtained in rice processing. Included in this category were bran, polish an hulls. The speaker quoted representative figures for the proximate analyses of these three materials, and compared the character of the oil from rice bran with that of cottonseed, corn and peanut oils. The protein content of the bran and polish was compared with that of corn and wheat; the type of protein present is favorable from the standpoint of utilization as feed because of the particular amino acids present. Bran is regarded as possibly the best natural source of vitamin B_1. Solvent extracted bran would have very little fat content, but would have an augmented protein and vitamin content over unextracted bran.

Samples of crude and refined rice oil were exhibited.

The speaker then dwelt on the subject of rice hulls and mentioned their high ash (21 percent or over, practically all silica). Loose hulls have a high thermal insulating value. They contain cellulose of high quality but the fiber is extremely short. Rice hulls yield somewhat less furfural than oat hulls or corn cobs because of the lower pentosan content. In all, between 2 and 30 uses for rice hulls have been explored but thus far no commercial use in volume has been developed.

Discussion

The following additional points were brought out:

1. Feeding tests with swine at the University of California show definitely that rice bran in the ration does not necessarily result in soft pork. (Mr. W. M. Regan who made this statement subsequently furnished the followir information quoted from University of California Agricultural Experiment Station Bulletin 420, by E. H. Hughes (1927).

Lot Number	Ration	Melting Point of Fat: Leaf Fat	Melting Point of Fat: Back Fat
II	Ground barley and tankage	45.7° C.	37.2° C.
VIII	Rolled barley, rice bran and tankage	45.7° C.	35.9° C.

Conclusion: Soft pork was not produced when rolled barley, rice bran and tankage were self-fed in dry lot.)

2. Tests are expected to be made at Davis using rice hulls as a mechanical adjunct to the ration to stimulate more effective ruminant digestion.

3. Ground rice hulls are of no great value as a substitute for wood flour ir plastics because of their high silica content.

4. The grinding of hulls, especially to fine sizes, is a costly operation and the abrasive action on equipment is very severe.

5. Rice hulls can be bonded with a plastic resin and overlaid on a masonite board to give structural strength. The hulls gave the board a pleasing appearance. (Samples exhibited by Mr. A. M. Partansky, Dow Chemical Co.)

6. Research in utilization of rice hull fiber at the Fiberboard Company has been abandoned because of the shortness and brittleness of the fiber. Utilization of the alkali extract of hulls for sizing has also been abandoned. (Mr. L. Rosenstein, Consultant).

RESEARCH ON RICE AT THE WESTERN REGIONAL RESEARCH LABORATORY

by

Ernest B. Kester, Western Regional Research Laboratory

Efforts have been directed toward the stabilization of brown rice by solvent extraction. This treatment, preferably performed with petroleum ether, removes the portion of oil most subject to change, particularly in the property of fatty acid development. Rice thus treated has been stored together with controls over definite time intervals and evaluated by a panel on the basis of flavor and odor. After storage, flavor differences were more or less equalized in cooking, but the odor of the extracted rice was more acceptable than that of the unextracted, and about the equal of rice preserved at -30° F. The results indicated that bruising of the oil-containing cells of brown rice in the shelling operation was responsible for a large portion of the extractable oil.

To investigate more thoroughly the oil-bearing portions of rice, separations were made of pure bran and germ fractions. It was found that the bran had an initially higher concentration of fatty acids and developed acids more rapidly than the germ.

The rate of fatty acid development in rice bran was found to decrease with lowering of moisture content. Heating with dehydration at 105-110° C. inhibited subsequent acid development, but lipolytic action was restored when the bran was allowed to rehydrate. The same heat treatment without dehydration destroyed activity almost completely. This effect of moist heat suggested a short steam treatment of undried rough rice as a means of stabilizing the grain after the hulls are removed. Steaming times as short as one minute were effective. This treatment was also applied to rice bran with favorable results. Means have been developed for rapidly measuring lipase activity in rice bran. The lipase activity parallels the development of acids in the oil of the bran.

Rice bran oil extracted from fresh bran and refined, winterized and deodorized, has stability comparable with the commoner edible vegetable oils.

Future research will be concerned with: (1) an investigation of other effects of steam blanching on rice, including any development of color in the completely milled grain, changes in the milling characteristics of the rice,

and changes in the color of the bran oil; (2) minor constituents of rice oil including the wax fraction; (3) source of lipase activity and additional methods for inhibiting it; (4) investigations of enzymes that may be responsible for the development of rancidity in brown rice and rice bran.

Discussion

The important facts and opinions stated were as follows:

1. There is believed to be considerable variation in the oil content of rice of different varieties. (It was subsequently found that 1.62% to 2.54% has been reported as the range of oil content for a number of American varieties These figures are included in National Research Council Bulletin No. 112 (1945) by Kik and Williams: Nutritional Improvement of White Rice.)

2. Steam blanching of rice as has been carried on at the Western Regional Research Laboratory results in little or no destruction or loss of thiamin according to initial figures.

3. Rice is not bought or consumed importantly on the basis of thiamine content, and the amount of this vitamin is so low, even in brown rice, that in countries of low per capita rice consumption, reliance would have to be placed on some other source to furnish the daily human requirements. The problem of storing rice in warm damp climates is a pressing one. Exports of rice from the United States amount to about 8 million pockets annually; 8.5 million pockets are consumed in the United States and about 3.5 million in the territories. (Mr. Harry M. Creech, RMA Rice Advisory Committee, California Rice Exporters)

RESEARCH ON RICE AT THE SOUTHERN REGIONAL RESEARCH LABORATORY

by

R. O. Feuge, Southern Regional Research Laboratory

Research on rice and derived products has been in progress at the Southern Regional Research Laboratory for a relatively short time. The problems worked on to date can be divided into four phases; namely, (1) storage of rough rice, (2) storage of rice bran, (3) processing of rice bran oil, and (4) utilization of the oil.

Storage of rough rice. Southwestern rice is frequently delivered for storage while it still contains relatively large amounts of moisture, and is therefore subject to heating and deterioration during storage. Investigations at the Southern Regional Research Laboratory have revealed that the spoilage of wet rice can be arrested for a limited time by the application of chemical treatments. Some treatments used to date have imparted off-tastes; others apparently have been entirely successful.

Storage of rice bran. A high-grade edible oil can be extracted from rice bran, but rice bran (at least the Southwestern varieties) contains enzymes which rapidly hydrolyze the oil. Under some conditions the free fatty acid content of a bran was found to increase at the rate of one percent per hour. It was discovered that drying the bran at elevated temperatures inhibited the formation of free fatty acids, but that as soon as the bran was allowed to absorb

moisture from the atmosphere, rapid formation of free fatty acids commenced again. Oil in bran from so-called "Converted" rice does not hydrolyze as rapidly as the oil in ordinary bran.

One article on the hygroscopic equilibrium of rice and rice fractions is now in press and an article on the storage of rice bran is being prepared for publication.

Processing of rice bran oil. Freshly milled rice bran has been extracted with commercial hexane and the recovered oil and extracted meal examined for their respective content of wax. Oils were refined and bleached by standard as well as several special methods. The crude, caustic soda refined, and several refined and bleached oils were examined spectrophotometrically. It was found that a good quality rice bran oil responds satisfactorily to conventional refining and bleaching. If the temperature of the solvent used in extraction is kept low, wax will not be extracted with the oil, but hot solvents will extract the wax. The wax possesses characteristics which should make it more valuable than the oil on a pound for pound basis. The results of these investigations are described in greater detail in an article which has been published in the Journal of the American Oil Chemists' Society.

Utilization of the oil. An investigation has been made of the chemical characteristics and composition of one refined rice bran oil and two crude oils. These oils were obtained by solvent extraction of commercial rice brans from Texas-grown Blue Bonnet and Arkansas-grown Zenith varieties of rice. The results have been published recently in an article in the Journal of the American Oil Chemists' Society.

In another investigation, a refined and bleached rice bran oil has been evaluated as an edible oil. The material was found to possess all the requisites of a choice cooking oil. In addition, its stability or resistance to oxidation was found to be superior to that of other vegetable oils. It winterizes more readily than does cottonseed oil. Hydrogenated fats made from rice bran oil are very stable and possess physical characteristics almost identical with those of corresponding cottonseed oil products. An article on the utilization of rice bran oil is in press and another one is being prepared for publication.

Discussion

1. No investigation has yet been made at the Southern Laboratory of phosphorus-containing compounds in rice oil.

2. A knowledge of the factors affecting the stability of rice oil is of importance to the rice industry.

3. Studies in the equilibrium moisture content of rough rice as a function of temperature and relative humidity, would provide data of great importance in the storage of rice in hot humid climates. The Southern Regional Research Laboratory has already published some information bearing on this point.

4. The possible toxicity of some of the chemicals being used in the studies on stabilization of rough rice, was discussed.

UTILIZATION OF RICE HULLS

by

F. P. Griffiths, Western Regional Research Laboratory

The subject was discussed with particular reference to work at the Northern Regional Research Laboratory.

The uses of hulls fall into two major classes: (1) Promising uses, as in the soft grit blasting of metals, and as insulating material during the cooling of iron ingots; (2) Possible uses, as for fillers in thermosetting plastics, fillers in plastic glues, fillers in light-weight concrete, thermal insulation (if made fire- and vermin-proof), source of furfural.

Hulls are not promising as a source of cellulose because of high ash content Manufacturers are not interested in hulls as a filler for linoleum. No commercial plant is now operating to produce activated carbon from hulls. The dry distillation of hulls does not hold much promise. Production of furfural on the West Coast is not attractive, due to lack of demand; also, there are not enough hulls available to justify operation of a large-scale plant. It has been estimated that to operate economically, a plant would require about 80,000 tons of hulls per year within a small geographical area, and this condition could scarcely be met in California. The Army and Navy have no immediate concern in soft-grit blasting of metals. In considering the use of hulls as a source of fiber, there is little promise in this field as the fibers are quite short and brittle, the yield is poor and the fibers do not mat properly.

Discussion

The following additional points were brought out:

1. Although furfural is used in refining petroleum oil on the West Coast, the make-up required is not large.

2. No rice hulls are now being used for soft grit blasting of metals.

3. In the bedding-down of iron ingots, only about one ton of hulls a day is being used in California.

4. The only large-scale outlet for hulls, in our present state of knowledge, would be in the fabrication of wall boards or as insulating material. Such a project might warrant a program of research and development.

ROUND-TABLE DISCUSSION

Led by

H. S. Olcott, Western Regional Research Laboratory

Dr. Olcott opened the round-table discussion by asking Mr. John B. Dobie of the Agricultural Engineering Division at Davis to discuss the drying of rough rice by infra-red radiation. Mr. Dobie stated that there are two

experimental driers at Davis, a rotating drum type and a revolving table type, which are being used for fundamental studies of infra-red drying. The revolving table drier subjects the rice to a heating period of 42 or 68 seconds without air movement, followed by a cooling period in an air blast of $1\frac{1}{2}$ to 3 minutes duration for each pass. The rice can be recirculated through the drier for as many repeat runs as desired. The most satisfactory results were obtained with numerous repeat passes at 42 seconds exposure to heat and about $1\frac{1}{2}$ minutes in the cooler per pass. Maximum rice temperature was 122° F. Five percent of moisture was removed with a total of 10 minutes' exposure to heat and 22 minutes in the air blast. The heating load was 9.75 Kw. for approximately 900 pounds of rice per hour. High temperatures, e.g. 145°, ruin the rice resulting in a yield of only about 20 percent of head rice. Experiments on commercial infra-red driers are being carried on at Richvale. It was reported that when low temperatures were used (80-85°), a yield of 63.2% of head rice was obtained as a season's average.

Mr. Harris stated that in plants operating at Richvale this type of rice-drying appeared to be considerably more costly than conventional sources of heat.

The subject of the importance or non-importance of brown rice was introduced. Mr. Creech expressed his belief that there was very little future in brown rice as far as United States rice is concerned. Early in World War II, the Army decided to use brown rice because of its thiamin content, but the experiment turned out badly. The rice was not stored under favorable conditions and soon molded and spoiled. Parboiled rice had a better experience. Mr. Creech thought that there was a general distaste for bran, and that the efforts of the flour and baking industries to popularize whole wheat bread had proved disappointing. (It was subsequently learned that the percentage of bread made in the United States from dark wheat flours (whole wheat, cracked wheat, etc.) was slightly more than 12 percent of all bread sold.) We should first concentrate research on a method for transforming white rice into an acceptable quick-cooking product, rather than try to stabilize brown rice.

Mr. Beiner of the College of Agriculture, University of California at Davis, had made a trip to Japan and learned that the Japanese do not care for brown rice for the reason that it brought on digestive disturbances and was difficult to cook.

Dr. Olcott asked for opinions from the producers of vegetable oils regarding rice oil. The following points were brought out:

1. Rice oil has had a bad name in the past, but if it can be produced in high enough quality and in sufficient quantity, it will be sold by the oil companies in the edible field.

2. Oil operators desire a more uniform bran as the product now contains widely varying proportions of hulls, broken grain and polish.

3. Extracted rice bran is approximately equivalent in feed value to wheat bran.

4. If bran can be stabilized by extracting the oil, more of it will be diverted to oil extraction, as oil mill operators are interested in rice oil as a means of increasing the output of their mills.

5. Extracted bran is becoming recognized in California, but is less known in other parts of the country. Oil operators are still forced to take a loss in selling it.

Subsequent to the meeting one of the participants stated that there was considerable disappointment in the rice industry that no research was being done on hulls in either the Western or Southern Regional Research Laboratories which are situated in centers of rice production and milling.

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CONFERENCE ON RICE RESEARCH

Western Regional Research Laboratory

February 17, 1949

LIST OF ATTENDANCE

Name	Organization	Address
Bainer, Roy	University of California.	Davis, California.
Bayles, Worth	Bayles and Joost.	San Francisco, Calif.
Blum, John E.	Durkee Famous Foods.	Berkeley, California.
Boggs, Mildred M.	Western Reg. Research Lab.	Albany, California.
Brewer, George W.	Rice Growers Assoc. of Calif.	Sacramento, California.
Brown, A. H.	Western Reg. Research Lab.	Albany, California.
Burr, Horace K.	Western Reg. Research Lab.	Albany, California.
Callaghan, C. W.	Calif. Vegetable Oil Company	Berkeley, California.
Callaghan, Eileen G.	C.E.Grosjean Rice Milling Co.	San Francisco, Calif.
Casto, George D.	Federal Trade Commission	San Francisco, Calif.
Chesley, Carl C.	Rice Growers Assoc. of Calif.	Sacramento, California.
Claus, Wilbur S.	Albers Milling Company.	Oakland, California.
Copley, M. J.	Western Reg. Research Lab.	Albany, California.
Cone, E. E.	H. M. Shanzer Company.	San Francisco, Calif.
Court, A. B.	Consultant.	San Francisco, Calif.
Creech, Harry M.	Calif. Rice Exporters, RMA Rice Advisory Committee.	San Francisco, Calif.
Davis, Loren L.	University of California.	Davis, California.
Des Jardines, R. E.	Cal-Oro Rice Growers, Inc.	South Dos Palos, Calif.
Deubner, Julius C.	Calif. Farm Bureau Fed.	Berkeley, California.
Dobie, John B.	University of California.	Davis, California.
Douglas, Florence M.	C.E. Grosjean Rice Milling Co.	San Francisco, Calif.
Drew, Leland O.	Production & Mktg. Admin.	Berkeley, California.
Fagan, E. J.	Producers Rice Milling Co.	Stockton, California.
Feder, A. G.	H. M. Shanzer Company.	San Francisco, Calif.
Feuge, R. O.	Southern Reg. Research Lab.	New Orleans, Louisiana.
Gaiser, Conrad J.	Dorward and Sons Company.	San Francisco, Calif.
Gratz, Dehaven	Consulting Engineer.	Richmond, California.
Green, M. D.	M. D. Green Rice Milling Co.	San Francisco, Calif.
Griffiths, Francis P.	Western Reg. Research Lab.	Albany, California.
Hale, W. S.	Western Reg. Research Lab.	Albany, California.
Hansen, H. Howard	The V.D. Anderson Company.	Oakland, California.
Harris, Glen R.	RMA Rice Advisory Committee.	Richvale, California.
Havighorst, C. R.	Food Industries magazine.	San Francisco, Calif.
Higgins, F. Hal	Rice Journal.	Oakland, California.
Hoffman, F. W.	State Depart. of Agriculture	Sacramento, California.
Houston, David F.	Western Reg. Research Lab.	Albany, California.
Hunter, Irving R.	Western Reg. Research Lab.	Albany, California.
Kester, Ernest B.	Western Reg. Research Lab.	Albany, California.
Koch, Charles H.	Oil Seed Products Company.	Fresno, California.
Kolb, A. R.	Philadelphia Quartz Company.	Berkeley, California.

Name	Organization	Address
Leahy, Marshall E.	RMA Rice Advisory Committee, Farmers' Rice Growers Cooperative.	San Francisco, Calif.
Luther, E. E.	Chemurgic Corporation.	Turlock, California.
Matchett, John R.	Western Reg. Research Laboratory.	Albany, California.
Mengola, George D.	Farmers Rice Growers Cooperative.	San Francisco, Calif.
Moutrey, A. E.	Rice Producer.	Willows, California.
Mrak, Emil M.	University of California.	Berkeley, California.
Nicholas, J. J.	Farmers Rice Growers Cooperative.	San Francisco, Calif.
Olcott, Harold S.	Western Regional Research Lab.	Albany, California.
Partansky, A. M.	The Dow Chemical Company.	Pittsburg, California
Perala, Walter	State Department of Agriculture.	San Francisco, Calif.
Ramage, W. D.	Western Regional Research Lab.	Albany, California.
Rasmussen, Clyde L.	Western Regional Research Lab.	Albany, California.
Regan, W. M.	University of California.	Davis, California.
Ritterband, J. S.	Cal-Oro Rice Growers, Inc.	San Francisco, Calif.
Roberts, R. L.	Western Regional Research Lab.	Albany, California.
Rosenstein, Ludwig	Consultant, Fiberboard Products, Inc.	San Francisco, Calif.
Simpson, T. H.	The Coronet Olive Oil Company.	Oroville, California.
Touton, L. L.	Oil Seed Products Company.	Fresno, California.
Tuttle, Charles W.	Rice Grower.	Colusa, California.
Van Atta, G. R.	Western Regional Research Lab.	Albany, California.
Whalen, Carl A.	Production & Mktg. Administration.	San Francisco, Calif.
Willard, R. E.	Willard Engineering Company.	San Francisco, Calif.
Zebal, O. F.	Rosenberg Bros. and Company.	San Francisco, Calif.

REPORT OF PROCEEDINGS

Second Annual Conference on Rice

Western Regional Research Laboratory

March 27-28, 1950

Auspices: Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture

This report contains the papers presented by the various speakers at the conference; also the main contributions offered during the discussions. Supplementary information on any particular topic may be obtained by writing to the delegate concerned. Names and addresses are given at the end of the Report.

Western Regional Research Laboratory
Bureau of Agricultural and Industrial Chemistry
Agricultural Research Administration
U. S. Department of Agriculture
Albany 6, California

PROGRAM

Monday, March 27

10:00 a.m.	Introductory Remarks	M. J. Copley, Director Western Regional Research Laboratory
	Rice Research of the Bureau of Agricultural and Industrial Chemistry	C. F. Speh, Assistant Chief Bureau of Agricultural and Industrial Chemistry, Washington, D. C.
	Rice Research Needs	L. C. Carter Arkansas Rice Growers Cooperative Stuttgart, Arkansas
	Nutritional Aspects of Rice	Agnes Fay Morgan, Department of Home Economics, University of California Berkeley, California
12:30 p.m.	LUNCH	
2:00 p.m.	Processing and Utilization of Rice Bran and Oil	K. S. Markley Southern Regional Research Laboratory
	Effect of Chemical Treatment on the Storage Behavior of Rough Rice	A. M. Altschul Southern Regional Research Laboratory
	Rice Research Program at Western Regional Research Laboratory	H. S. Olcott Western Regional Research Laboratory
	TOUR AND DEMONSTRATIONS	

Tuesday, March 28

9:30 a.m.	Rice Varieties for California	A. H. Williams Bureau of Plant Industry, Soils and Agricultural Engineering Biggs, California
	Engineering Aspects of Rice Drying	H. A. Kramer Bureau of Plant Industry, Soils and Agricultural Engineering Beaumont, Texas
	Some Commercial Food Products from Rice	E. B. Kester Western Regional Research Laborator
	Taste Test Procedures at Western Regional Research Laboratory and some Results for Frozen Cooked Rice	Mildred M. Boggs Western Regional Research Laborator
12:30 p.m.	LUNCH	
2:00 p.m.	Round Table Discussion Contributors:	J. Roy Allgyer Agricultural Research Administratio Washington, D. C. Executive Secretary, Rice Advisory Committee
		G. W. Brewer Rice Growers Association of Califor Sacramento, California
		H. M. Creech California Rice Exporters San Francisco, California Member, Rice Advisory Committee
		G. R. Harris Rice grower Richvale, California Member, Rice Advisory Committee
		M. E. Leahy Farmers Rice Growers Cooperative San Francisco, California Member, Rice Advisory Committee

Welcoming Remarks
by
M. J. Copley, Director, Western Regional Research Laboratory

Dr. Copley opened the Conference with a welcome and greeting to the members of the rice industry present. He made reference to the fact that a year ago the Western Regional Research Laboratory had held its first Rice Conference to provide for an exchange of ideas between those who were actually engaged in research on rice, and those who dealt with the more practical problems of growing, harvesting, milling and selling rice. From discussions subsequent to the papers, and comments later received it was clear that the rice industry appreciated the opportunity of becoming more conversant with what is going on in rice research. Furthermore, the research workers of the Laboratory profited greatly this past year by knowing the viewpoint of the industry. For this reason, a second Conference was called, which he hoped will be even more successful than the first in accomplishing its purpose.

Rice Research of the Bureau of Agricultural

and Industrial Chemistry

by
Carl F. Speh
Assistant Chief, BAIC

Until late in 1947, rice was not an assigned commodity in the Regional Laboratories, and, except for some exploratory work at the Southern Laboratory, the progress we are able to report in our studies, has all been made in the last two years. We were authorized to work on rice under the Research and Marketing Act of 1946 which provided funds for this purpose.

This Conference is one of two being held this spring on the subject of rice. The first was in New Orleans about two weeks ago. We felt the need for two conferences as the types of work being done at the Western and Southern Laboratories are very different, and the distance between the two places is so great as to make it difficult, if not impossible, for all those in the industry who are interested, to attend a combined meeting.

Investigations on rice at the Southern Regional Research Laboratory have to do primarily with problems incidental to production. In the south where adverse climatic conditions prevail, the storage of rough rice is more of a challenge than in the west, and is therefore receiving a great deal of attention at the Southern Laboratory. Dr. Altschul's division is investigating means for preventing the deterioration of undried rough rice by addition of specific chemicals or treatments, and he will have more to say on this subject in his talk. The utilization of rice bran and especially the technology of production of rice bran oil is also being studied at the Southern Laboratory; the work of the Oil Division there is concerned with the problems of solvent extraction and refining the oil, and finding its proper fields of usefulness.

The Western Laboratory devotes much of its effort to utilization of the fully milled rice, whether it be as whole or broken kernels, and has already found several new possibilities by which this grain may become consumed in greater amounts than at present. Also included in the program of the Western Regional Research Laboratory are studies in the preservation of brown rice, and, I believe, in the isolation of antioxidants from rice bran.

Rice Research Needs

by
L. C. Carter
Arkansas Rice Growers Cooperative

The speaker extended greetings from the rice industry of the south. He stated that he would not attempt to list all the needs of the rice industry nor offer solutions for the problems, but rather would present several ideas in order to stimulate interest and questions for discussion.

The primary aim of all rice milling is to achieve a maximum yield of whole rice grains. As broken grades sell for only about 50 percent of the price of head rice, it may be computed that the industry loses $28,800,000 annually from breakage alone. It is recognized, of course, that it will never be possible to eliminate the broken grains. This figure is given only to emphasize the necessity of keeping the broken content to the lowest possible minimum. About 5 percent of the total broken grain is already checked or broken before the rice ever reaches the mill, which means a loss of over a million dollars from this source. It is, therefore, desirable to develop through research, equipment for harvesting, drying, storage and milling that will reduce the amount of breakage to the lowest possible figure.

Drying. We need to know much more about drying conditions and methods which will produce desirable milling quality and color. Research is recommended that will apply to both farm and commercial dryers. We need definite and positive data on proper drying conditions - humidity, temperatures, and air velocities - as well as methods of blending rice to give satisfactory milling results.

Storing. There is no such thing as a safe lot of rice for storage when dried in the usual manner after combining. The problem of bulk storage is quite different from that of sack storage. Effects of varying quantities of CO_2 and turning bulk rice need to be determined. By withdrawing air at the base of bins holding a 100-foot column of rice, the grain has been safely held for about two to three months at 20 - 22 percent moisture. Additional research is badly needed on use of aeration in storage. This aeration procedure can be used for three purposes: (1) to build up lots of rice in bulk storage over a two or three-day period, (2) to delay the periods between drying steps, (3) to serve as a substitute for turning in the case of stored rice.

Rice in bulk storage with an initial moisture content of 13-14 percent, after aerating, turning or other handling steps, may be reduced to 12, 11 or even to as low as 10 percent moisture. How can we maintain the moisture content in rice at its optimum level, which is about 14 percent, during storage? Loss of moisture affects milling quality and also represents considerable reduction in value due to weight loss. Another problem to be investigated is the fumigation of packaged rice, and bulk rice before packaging.

Equipment. We would like to know how, where and why breakage occurs during milling. It might be well to attempt the use of the more modern techniques such as electronics. An electric-eye machine might be developed that would grade out dark grains or weed seeds.

Would it be of advantage to control the humidity of the entire mill or of individual operations? It is possible to humidify the bran coat on rice with a little steam, so that it will come off more easily. We are now actually doing this in the mill; it seems to facilitate removal of the bran, reduces breakage during milling, and therefore gives us a better yield of head rice. This treatment also lowers power requirements and the output of total rice is increased since less scouring is necessary.

Hulls. About 20 percent of rough rice consists of hulls, the disposal of which is still a serious matter in many areas. At the Arkansas Rice Growers Cooperative, we are now selling all our hulls - mostly to fertilizer companies. They are used in mixed fertilizers to prevent hardening and caking.

Bran. Rice bran is used for feed and extraction of oil. The rice industry is now about ready to accept the fact that rice oil is a valuable product worth recovering. We would like to have work continued on the free fatty acid problem of rice oil.

Polish. We would like to see polish used for human consumption rather than for stock feed. It contains considerable nutrients and high amounts of vitamins.

Marketing. Marketing is the main problem facing the rice industry today. This itself is a research problem. Rice at a world consumption level of 105 pounds per capita, is mankind's most important food. In the United States consumption is only about 6 pounds per person. We still have international shortages of rice. Production is about the same as pre-war levels, but due to increased population, per capita production is actually less than pre-war. The United States is the third largest export country.

Three methods are suggested for solving our surplus rice problem: (1) finding means for selling our surplus rice at world market prices, (2) reduction of acreage devoted to rice, and (3) increasing domestic consumption. The third point is the most important. Advertising is of great value. The Rice Consumer Service of Louisville, Kentucky, which is supported by a number of southern and California Cooperatives and Mills, has on file 1800 recipes for preparing rice dishes, and distributes them to the popular press and various magazines. We also need some sort of project to educate the nutritionists on the good points of rice as an article of diet. Here are some of its good points:

1. It can be served in many hundreds of ways.

2. It blends well with and can be used to "stretch" other more expensive foods. In this respect it is superior to any other cereal grain.

3. It can be cooked and then kept for some time in a refrigerator without loss of texture and flavor.

4. It is easily and completely digested.

5. Finally, a rice diet is said to be of value in reducing high blood pressure. This point is questionable, however, and should be thoroughly investigated.

The Nutritional Value of Rice

by
Agnes Fay Morgan
University of California

Rice is the most important food in the world in terms of number of people dependent on it for most of their caloric intake. Rice consumption in the United States is limited even in the rice producing states. The nutritional defects of polished rice are of grave import to the rice-dependent people of the Orient, but are less so in the United States where large quantities of other foods are eaten with rice.

Polished rice is a multi-deficient food, with thiamine deficiency first and most critical, but protein, riboflavin, vitamin A, ascorbic acid, iron and calcium are also low. Most of these deficiencies result from the removal of the bran and polish layers of the grain, since these layers contain the major part of the vitamins and minerals, and the best protein of the grain.

Four methods of correcting the deficiencies of white rice have been proposed and each has advantages and disadvantages.

a) Brown rice may be substituted for the milled variety. This is the simplest, cheapest and most effective device. But many people may refuse to accept brown rice, at least without a somewhat lengthy gradual education and introduction of the product. The keeping qualities of the brown rice are inferior. Both these difficulties are not insoluble.

b) Undermilled or unpolished rice may be used. Technical difficulties in the matter of control of degree of milling arise but the yield of rice per pocket is appreciably increased. Again public taste may not at first accept the product.

c) Parboiling or soaking and steaming the whole rice before milling prevents much of the loss of vitamins. Its effect on minerals and amino acids content has not been adequately determined.

d) Thaimine and other vitamins and/or minerals can be added to one or two percent of the white rice by a soaking operation, the grains covered by a protective coating, dried and then distributed throughout the remaining amount of rice. Washing, cooking and storage are said not to affect much loss of the vitamins. This is an expensive, uncertain and incomplete solution of the problem and one which is particularly unlikely to be accepted in Asia.

Much research remains to be done particularly as to the amino acid content of rice proteins and the distribution of vitamins other than thiamine, riboflavin and niacin in the various rice products.

Discussion

Mr. Creech asked what effect fertilizing and variety would have on proteins. Dr. Morgan replied that both the protein value and amount could be improved.

Mr. Carter asked about relative losses of B vitamins in storage of paddy and milled rice, and of the degradation of proteins. Dr. Morgan replied that the relative loss and degradation became greater from paddy to brown to white rice, even though the absolute amounts became less.

Mr. Carter brought up the question of the possible effect of carbon dioxide on rice during storage. No definite answer seemed available on this point.

Dr. Morgan pointed out, with regard to vitamins, that the brown rice has sufficient thiamine to aid digestion of the starch in the kernel but that white rice did not.

Dr. Morgan further called attention to the fact that only a beginning had been made on the changes in amino acids during protein degradation, and that much more study was needed. She cited numerous references to studies on amino acids and vitamins.

Processing and Utilization of Rice Bran Oil

by
K. S. Markley
Southern Regional Research Laboratory

Dr. Markley summarized briefly the position of rice in world cereal crops, including the 16% increase in annual U. S. per capita consumption from 1930 to 1944 and the rise in proportion of world exports from 0.9 to 19.9% during the period 1934 to 1947. He further pointed out that rice had received little scientific investigation in this country. The Department of Agriculture entered actively into this field following allotment of funds from the Research and Marketing Act of 1946, when investigations on storage of rough rice and on processing and utilization of rice bran oil were assigned to the Southern Regional Research Laboratory. Investigations on bran and oil are summarized in this report.

Average commercial rice bran represents about 8,5% of whole rough rice, and contains 14 - 18% of fatty materials. Studies in progress at the Southern Regional Research Laboratory of 10 long and medium grain rices for 3 crop years from 3 southern states indicate the true bran represents 3.4 to 6.2% of the rough rice on moisture free basis and contains 18.4 to 24.6% oil. The commercial bran figures reflect admixtures of other materials.

Proper removal of the fatty portion from the bran (consisting of glyceride fats and fatty waxes) increases proportionately its content of protein and other nutritives for feeds. The oil is of higher economic value than the bran. Within the past year 50- and 80-tons-per-day bran extraction plants have begun operation in Texas and California. Investigations on the bran and oil at the Southern Regional Research Laboratory have shown that (1) bran can be solvent-extracted by batch or continuous processes, (2) the crude oil presents refining problems, (3) the refined and bleached oil - an excellent cooking and salad oil - can be readily winterized and used for mayonnaise and salad dressings, (4) the oil is resistant to rancidity, but has a slight tendency to flavor reversion, (5) the oil can be hydrogenated to an extremely stable fat of shortening consistency, and (6) the bran can be stabilized to allow transportation and storage before extraction. Studies are progressing on recovery of phosphatides, waxes and antioxidant concentrates.

The great stability of the oil cannot be attributed to its fatty acid composition or tocopherol content. A search for the active stabilizer is being made.

The high refining losses in processing rice oil are a serious problem. Crude oil with less than 5% acids obtained by hot hexane extraction may give losses of 20 to 35%. Cold hexane extraction, degumming by water washing, and initial steam-refining all cut down these excessive losses but do not eliminate them. The probable cause has now been indicated as the presence of monoglycerides, which are extremely active emulsifying agents. A concentrated attack is being made on this problem, with the confident belief that it will be overcome and an important barrier to the full utilization of rice bran oil will be removed.

Effect of Chemical Treatment on The Storage Behavior of Rough Rice

by
A. M. Altschul, Southern Regional Research Laboratory

Storage conditions in the South are more difficult than in California and some of the problems may be different. This report gives a brief view of the type of program under way for studying these problems, and presents particular examples of some investigations.

Use of Chemical Treatment to Prevent Heating of Moist Rice Previous to Drying: The use of biological inhibitors was suggested by their favorable effects on cotton seed and Texas flaxseed. In the first experiments attention was given only to possible results; costs and toxicity were not considered. Treatment was with bis-chloromethyl-xylene and propylene glycol dipropionate. Moisture content was artifically raised to 20%; it being noted that these conditions are not strictly comparable with those in naturally moist rice.

In the first example, studying temperature rise, four 2-barrel bins of rice were used. Two were controls, one of which was cooled by turning whenever the temperature reached 100°F. Two bins contained treated rice. In these the temperature did not go over 80°F. In the turned control, the rice repeatedly heated even when moisture had been reduced to 12%.

A second similar experiment studied carbon dioxide formation. The atmosphere of the control went to 20% carbon dioxide, even after repeated turning. The treated samples generated only about 4% carbon dioxide in the atmosphere. Free fatty acids in the controls went to about 12% (based on oil) in four weeks storage as paddy rice, but the treated samples stayed at 3.5 - 4%.

The odor and flavor of the rice was affected by the chemicals in these experiments.

A third example illustrates the use of an aqueous spray of acetic acid and sodium metabisulfite. At 0.6% each these chemicals were effective in holding moist rice, but changed the taste. At 0.3% concentration, taste was not modified, and the treatment was effective when combined with aeration.

Fresh rice with 26% moisture was used. Two control samples and two samples treated with 0.3% sodium metabisulfite and 0.16% acetic acid were studied. One control was turned at the end of 16 hours, and the others only after 87 hours. The delayed aeration was not very good. The fresh rice did not continue heating after repeated turning as did artifically moistened rice. Treated samples decreased to 10.5% moisture in 7 days, the early aerated control went to 13.7%, and the delayed aeration sample dropped only to 17%.

Use of Heat to Control Deterioration of Moist Rice: Investigations were aimed at learning whether heating which would cut down biological activity would also cause reduction in quality of the rice. A blanching treatment for 45 secs. in a screw conveyor was used with and without chemical treatment on rice which had been artificially moistened to 21% moisture. Rice temperature during blanching rose from 85°F. to 180°F. The control sample heated rapidly as before. The blanched sample did not heat for about two weeks, after which heating was serious.

The Role of Microorganisms in Heating and Deterioration: Seeds themselves have a natural production of heat, but growth of microorganisms also produces heat. Which is the effective cause of heating in moist rice?

An experiment was made on artificially moistened rice (21%) using an untreated control and a sample treated with acetic acid - sodium metabisulfite mixture. Measurements were made of changes in temperature and number of molds and bacteria. The control sample heated to above 110°F. in five days, though the bacterial count only increased 5-fold, and the mold count remained low until after three days. Heating seemed, tentatively, to result from the rice grains themselves. The treated sample heated to 95°F. in five days, after which evolution of sulfur dioxide ceased. The temperature rise was more rapid from this point. Molds and bacteria were reduced to small numbers by the treatment and remained low until after sulfur dioxide evolution stopped. Their increase was more rapid after this time.

It seems that initial heating is probably from the grain itself. The chemical treatment protects the seed for awhile, but afterwards it appears weakened and heating and deterioration become very rapid.

These examples illustrate the type of investigations on storage of rice being performed at the Southern Regional Research Laboratory. Other questions call for investigation. For example, why do rice grains check? Is it due to strains within the grain caused by drying? A Rice Technical Committee has been established in the Southern Rice Area, with A. M. Altschul as chairman, to discuss these problems and coordinate efforts of the various rice investigations.

Discussion: In reply to a question about the costs of the chemical treatment, Dr. Altschul stated that the cost of the chemicals was only about $0.50 per ton.

Mr. Speh asked about the artificial moistening. This was stated not to be necessarily the same as naturally moist rice, but allowed orienting experiments when naturally moist rice was not available.

Mr. Aronstamm asked whether the deterioration was in part due to an esterase. Dr. Altschul replied that it might be caused partially by an esterase or lipase, particularly in free fatty acid formation, but that heating is probably due to respiration processes. He said also that they plan to attempt identification of the enzymes concerned.

RESEARCH WORK ON RICE AT WESTERN REGIONAL RESEARCH LABORATORY

by
Harold S. Olcott, Western Regional Research Laboratory

The rice research objectives of the Western Regional Research Laboratory were described. Studies on the stabilization of brown rice have shown that 4 methods have potential usefulness. These are: (1) refrigeration; (2) decrease in moisture content; (3) removal of extractable lipids with solvents; and (4) steam treatment of rough rice, as it comes wet from the field, followed by the usual drying and dehulling operations.

Research work on new food uses for rice is actively in progress. Rice curls are prepared as follows: whole grain or broken rice is ground, mixed into a paste with hot water and extruded into a hot oil bath. The resultant snack item has proved to be of acceptable flavor and texture. A bulletin describing the preparation and properties of rice curls is available on request.

A puffed rice product can be made from commercial rice which has previously been treated by parboiling or by treatment with steam. The treated rice is heated for a short time either in hot oil or hot air. The product is a porous material having a volume approximately 4 to 5 times that of the original kernel. Untreated rice does not puff under these conditions.

Experiments have been conducted with the aim of producing a satisfactory quick cooking rice. Some progress has been made. The rice product obtained when whole grain rice is soaked, treated with steam, and exposed to a bath of hot air can be reconstituted in hot water to give an edible boiled rice dish in about 3 minutes.

It has been shown that it is possible to freeze and store precooked rice. After several months of storage the products have been judged superior to the original rice by trained panels. It is not known whether precooked, frozen rice would be an economically sound product.

Preliminary experiments are under way in which rice is being canned with a short heat treatment in the presence of the antibiotic subtilin. Previously, it had been possible to can only parboiled-type rices inasmuch as the rigorous canning schedules required cooked rice to an inedible mush. The present procedure permits the use of ordinary white or brown rice.

Rice Varieties in California

by
A. H. Williams, Rice Station
Bureau of Plant Industry, Soils and Argicultural Engineering
Biggs, California

The requirements of a satisfactory rice variety for California are that it must be hardy, must mature in about 155 days or less, must be a high yielder and of good quality. Furthermore it should be adapted to the machinery with which it is handled.

From a breeder's viewpoint, it has been very hard to replace either Caloro or Colusa because they are so well adapted to California conditions and probably these will be grown as long as short grain rice dominates the California production.

Experimentation in rice was inaugurated in 1909 near Biggs by the Office of Cereal Investigations under H. F. Blanchard. In 1912, about 1300 acres of rice were grown commercially in Butte and Colusa counties. This land was planted to Wataribune, which had come to the United States in 1908 from Japan, and which remained a leading variety until 1918. This is a late season, short grain type producing a high yield of good quality rice. Early Wataribune, which matures about ten days sooner, rapidly replaced it.

Prior to 1917, the Station tested and later released Caloro (C.I. 1561-1), Colusa (C.I. 1600), and Butte (C.I. 1564). The first two are the most prominent varieties in California today. Butte was the heaviest yielding but was too difficult to thresh. Colusa is a short grain awnless, Japanese type rice. It was released in 1917 on about 200 acres. It matures about 20 days earlier than Wataribune and does exceptionally well on new land. It has somewhat weak straw and often lodges when it becomes rank in growth. Yields are relatively high and milling qualities are reasonably good.

Jones released Caloro in 1921. This Japanese type is partly awned. It is a high yielder and of good quality, matures in about 155 days. Caloro is grown on about 80 percent of the acreage in California, but is also adapted to Arkansas, Louisiana and Texas where it is raised to a lesser degree.

In 1924 Jones crossed Caloro with Lady Wright, a long grain type, and out of selections made from this cross, one strain was named Calady, which was released in 1935 by L. L. Davis. Calady is a medium grain rice. It has a heavier straw than Caloro and matures about four days later. As it has a tendency to check if allowed to become fully ripe, it should be harvested before reaching maturity.

Conway was developed by Davis from Haya Kitabu (C.I. 6849) obtained by Jones in the Orient in 1925-26. This is a short grain awnless Japanese type rice, maturing about 4 days earlier than Caloro. It does not yield quite as much paddy as Caloro but is superior in yield of head rice. However, from the threshing standpoint it cannot be handled to good advantage with the combine harvester, so will probably fall out of the rice picture.

In 1948, still with a medium grain rice in mind, Davis released a variety called Calrose. It was produced by backcrossing Caloro to an F_1 plant from a cross Calady x Caloro in 1938. During succeeding years, many selections were made with this cross and the strain now known as Calrose was increased. Calrose matures at the same time and appears to have about the same adaptability on California soils as Caloro. Its paddy yield is as good as Caloro and it appears to have slightly higher head yields. Results of the 1949 harvest show that Calrose is able to stand more punishment from extreme dry weather at harvest time than Caloro. It appears to resist checking when overripe.

Caloro represented about 80 percent of the 1949 crop with 15 percent being planted to Colusa and the remaining 5 percent went into Conway, Onsen, Calrose and others. Next season, Calrose will probably be planted on about 25,000 acres which is about 10 percent of the land devoted to rice culture in California. Colusa will remain about the same, but Caloro will drop to about 75% to allow for the increased Calrose.

Introduction of new types of rice make the handling of the crop more complicated because mixtures of types become a problem. There is, however, need for a long grain type of rice for California. The medium grain Calrose will merely fill the gap until a long grain can be developed. At present the most promising long grain selections do not have the vigor or yield necessary for introduction into the California rice fields.

Caloro is recommended by the Biggs station for planting on old rice land or on land of average fertility. Colusa should be planted on virgin land or on soil that has been out of rice production for several years. It is also recommended that where one farmer has large acreages and his harvest period is spread out over several weeks, part of his acreage should be planted to Colusa so as to relieve pressure at harvest time.

There is probably no future for Conway. It is definitely not a satisfactory variety in an area where rice is combined directly. However, Conway will not shatter and hence may have a place in areas where stationary harvesting and swathing are still being practiced.

Promiscuous introduction of rice varieties is controlled in part by the Office of Plant Introduction, but still foreign varieties are getting through without quarantine inspection. Such practices should be discouraged as they lead to nuisances, - for example, red rice, whose weed habits are well known, - diseases and insect pests.

Engineering Aspects of Rice Drying

by

H. A. Kramer
Bureau of Plant Industry, Soils and Agricultural Engineering
Beaumont, Texas
(Paper read by C. F. Kelly, BPISAE, Davis, Calif.)

A single fully exposed grain of wet rice subjected to an optimum drying environment at each instant should dry to the desired moisture content with a minimum loss of quality. The problem of the engineer, after optimum conditions are known, is to design equipment which will uniformly subject all the rice grains to these conditions

Basic information on ideal drying conditions is being obtained and correlated with milling quality. Typical problems are illustrative. Proper harvesting maturity measured by moisture content (20 to 26%) is often unreliable because of weather conditions. A better measure is desirable. Temporary bulk storage of excessively moist rice causes quality deterioration. No practical drying method is available for grains that are hulled during harvesting. These grains, about 4 to 5% of the total, check during drying and lower head rice yields.

Laboratory drying studies of one-grain thick layers of rice have been made under controlled conditions of humidity, air velocity, seasoning, and milling technic. Control samples were air dried. Eighteen tests each were made on Zenith, Caloro, Bluebonnet and Rexoro, and four on Magnolia. Dry bulb temperatures of 90 to 142°F. were used with relative humidities of 11 to 84% and air velocities of one and two hundred feet per minute. Incomplete results indicate loss of milling quality at temperatures above 100°F., or where the higher velocity of drying air was used. In some cases milling was satisfactory at 130°F. dry bulb when the relative humidity exceeded 60%. Germination was satisfactory up to 110°F.

The air-dried standard showed the following average head rice yields (as percentages of total rice) when shelled with a "Smith Shelling Device": Zenith 86.8%, Caloro 85.6%, Bluebonnet 63.7% and Rexoro 62.8%. These varietal differences are not necessarily typical, as no account is taken of the influence of numerous other variables.

Bulk drying at commercial plants is much different. The operator must accept rice as it comes and try to maintain its potential milling qualities. He has little control over variations in maturity, moisture, size of lot received, quality, amount of hulled rice and foreign matter present.

In continuous driers it is common to empty and refill before drying a new lot. The first rice in is usually batch-dried 20 to 30 minutes before the discharge mechanism is started. Nonuniform drying results. It is recommended that the rice be recirculated during this initial period. It is also recommended that discharge temperature of rice should not exceed 100°F.

Drying in several stages is advantageous from the operator's standpoint. However, continuous drying at reasonably low temperatures by recirculation is not harmful. It is recommended for seed rice to prevent contamination or reduction of germination in the bin between dryings. It was found that, for the first 24 hours in concrete bins, rice with less than 15% moisture rose on the average 1°F. per 46.5 hours, with 15 to 18%, 1° in 13.1 hours, and with 18 to 22% in 8.6 hours.

Although ideal drying air temperatures are not established it appears that some upper dry bulb temperature (perhaps governed by germination loss) and some maximum temperature drop across the column may be practical control means. It appears that a 20 to 30°F. drop across a 6-inch rice column is not injurious. The amount of water that can be removed per drying cycle seems to depend chiefly on the rate. Good results are obtained when less than 2% is removed in 30 minutes. Rapid cooling of the discharged rice showed no loss in milling quality.

These data, with those supplied by agronomists, pathologists, physiologists and others, will furnish guide posts along the road to better rice drying, and help answer some of the questions still confronting the industry.

Discussion: Dr. Olcott pointed out that the best yield and milling quality resulted from very slow drying, but that costs were then too high.

Mr. Glen Harris stated that, with our California climatic conditions so different from those in the South, storage experiments in the Southern area might not answer all our California problems.

Some Food Products from Rice

by
Ernest B. Kester, Western Regional Research Laboratory

Because of the magnitude of this subject, the speaker confined his discussion to parboiled and brown rice, both of which have become important retail sales items in recent years.

The desirable features of parboiled rice are its high milling yields (due principally to gelatinization of starch) relatively high content of B vitamins and its good cooking qualities. Adverse factors are its brownish color, increased adherence of the bran to endosperm, and tendency of the rice to become rancid during storage. The work of Hinton on the concentration of vitamins in the various portions of the rice grain, and the movement that takes place during parboiling was discussed at length.

The color development in the parboiling of rice raises many questions that need to be answered, and should be the subject of an intensive investigation. The possibility of using a bleaching agent such as sulfite was mentioned, but in this case, adsorption of SO_2 by the endosperm may occur in amounts sufficient to impair flavor.

Samples of parboiled rice from the three plants producing it contained 0.68, 0.37, and 0.84 percents of ether extractable matter. All turned rancid within a few weeks after they were received. The research problem here is to find means of preventing this development such as by use of antioxidants, or by harder milling to reduce oil content to negligible values.

The possible use of steep liquors, which are now discarded, as substrates for growing microorganisms or for fortifying feeds was suggested.

Brown rice. Calculations from data in the Bureau of Agricultural Economics consumer acceptance survey of different forms of rice show that of all home makers interviewed, more than 12 percent indicated a liking for brown rice. Deterioration of this product in storage takes the form of development of free fatty acids in the bran oil, growth of microorganisms, insect infestations, and rancidification. The Rice Section of the Western Regional Research Laboratory has devoted considerable time and study to the first topic, and has found four methods by which fatty acid development may be inhibited: reduction of storage temperature, maintenance of low moisture levels in storage, solvent extraction prior to storage, and steam blanching. The effectiveness of

the various treatments was illustrated by curves. Brown rice maintained at 32°F. shows only a very slight development of acids for any moisture level as high as 14 percent. At 77°F., moisture should be reduced to below 9 percent, but at 95°, good control was only obtained at 3.2 percent moisture. Solvent extraction removes the portion of oil most susceptible to lipolysis. The oil becomes extractable as a result of bruising during shelling. Steam blanching of brown rice for one minute virtually destroys lipase so that fatty acid development over a period of 5 months is negligible.

Discussion

Mr. Creech: What difference is there in the rate of deterioration of undermilled and brown rice?

Dr. Kester: We have no comparative data on fatty acid development in these forms of rice, but if they follow the behavior pattern of rice polish and rice bran, the undermilled will not develop acids as rapidly as the brown rice.

The discussion then centered on vitamins.

Dr. Olcott: It has been found that SO_2 will destroy thiamin.

Mr. Creech: I do not believe this is important for rice is not sold on the basis of its vitamin content.

Miss Kennedy: Why do you parboil rice?

Mr. Creech: Its main value is to increase the amount of head rice produced.

Mr. Harris: Do fatty acid formation and rancidity occur simultaneously?

Dr. Kester: These are different reactions, but may occur together.

Mr. Court: What is rancidity?

Dr. Copley: A reaction between oxygen and oil causing off flavor or odor.

Mr. Harris: Is free fatty acid formation associated with deterioration?

Dr. Olcott: Not necessarily. It is possible to have a product with a high acid content and no rancidity.

Taste Test Procedures at Western Regional Research Laboratory and Some Results for Frozen Cooked Rice

by
Mildred M. Boggs, Western Regional Research Laboratory

Taste testing at the Western Regional Research Laboratory is for the purpose of characterizing the quality of food. This type of test differs from consumer tests in that no attempt is made to determine how poor samples may become before consumers object. For example, our taste panels can tell whether one antioxidant is more effective than another in preventing rancidity but they cannot tell how rancid a fat must become before consumers refuse to buy it.

Training of tasters involves critically examining samples of all qualities under investigation, agreeing on ways of describing each quality factor, and agreeing on the score to be given for a certain amount of deterioration. This often requires a month or more. Then a group of tasters are tested to see which ones are most consistent day after day. Finally, the coded experimental samples are scored by the best tasters and the scores are analyzed statistically.

We have used a trained, selected panel of tasters in developing frozen cooked rice. Cooking of polished rice consists of washing and draining the rice, adding 1 part of rice to 1.0 - 1.3 parts of cold water (the smaller proportion of water is used with short grain rice), and slowly boiling it for 10 minutes, then steaming it for 25 minutes (35 minutes for unfrozen rice). The cooked rice is packaged in cellophane bags, frozen and held at freezing temperature until just before it is used. At serving time the solidly frozen rice is put into a preheated steamer (a sieve set over boiling water can be used as a steamer) and heated for 10 minutes.

Storage studies with short and long grain polished rice have been completed. Each test series included frozen samples of one variety stored at -10, 0 and 10°F. and two freshly cooked samples. The dry rice for the latter were held at room temperature and at -30°F. Samples were scored after 1 week, 2 and 8 months of storage. Tasters scored whiteness, separation of grains, flavor and texture of each test series four times.

The differences between frozen and freshly cooked rice in all instances, even after 8 months of storage were too small to be of practical importance but they were statistically significant in favoring the frozen rice. The latter was whiter, had better texture (tender but dry) and tended to show better separation of grains. There were no consistent differences between the two freshly cooked samples or between the three frozen samples.

A similar study with short and long grain brown rice has been started. There were no differences between frozen and freshly cooked samples after 1 week of storage. The samples will be tasted again after 2, 6, and 12 months of storage. A similar study using long and short grain parboiled rice is planned but no samples have been tasted yet.

ROUND TABLE DISCUSSION

(Notes on the discussion were taken in long-hand by members of the Rice Section. It was impossible to record all of the remarks, but most of the important points were covered. In transcribing notes, it was attempted to be accurate, but under the circumstances errors may have been made.)

J. Roy Allgyer, Agricultural Research Administration, Chairman

Mr. Allgyer opened the meeting and asked for questions and comments.

Mr. Leahy: We are pleased with the serious attention being given to important research problems connected with rice.

Mr. Brewer: In general I am convinced of the importance of what is going on in rice research, but some of us feel that too much attention is being given to vitamins.

Mr. Creech: Time could be better spent on rancidity and fatty acid problems.

Mr. Leahy: Vitamins are a selling point and appeal to the housewife.

Mr. Brewer: Vitamins are desirable, but we must recognize that not enough are present in rice to make much difference in the total diet.

Mr. Allgyer: If rice consumption were doubled, it still wouldn't make too much difference in meeting the vitamin requirements of the average American.

Dr. Altschul: People don't worry too much about vitamins as was evident in a survey of housewives regarding orange juice. No one commodity can do the whole job of supplying a nutrient. In the case of rice, millers should make the most attractive product possible and save what nutritive values they can.

Capt. Court: The unacceptability of processed rice because of its color is not offset by its added vitamin content. If possible, good color and high vitamin content should both be obtained.

Mr. Harris: I believe we should aim at putting out rice in more different ways as an aid to the rice incustry.

Dr. Copley: Should we then direct our efforts toward producing most favored types of rice products - for example, making products from white rice?

Mr. Carter: The blending of rice with other nutritious foods, such as canning of rice with chicken, should be emphasized.

Mr. Creech: What we need is a good quick-cooking, fool-proof material that is easily stored and reconstitutes to a pleasing product with good texture.

Mr. Brewer: I think the frozen rice should come close to meeting this requirement.

Mr. Diehl: I believe the frozen rice is a great advance. With such a process, uniform results can be obtained, and in general it fits into the pattern of frozen foods. The housewife is accustomed to using them. The packaging problem may be relatively easy and there is no oxidation problem. From the ease-of-handling standpoint, frozen rice is a natural.

Dr. Copley: Agreed, if price limitations aren't too great.

Mr. Harris: Price is not too great a factor.

Mr. Creech: We should play up rice for the qualities that it has, rather than emphasize what it hasn't.

Mr. Carter: Yes. We should emphasize the excellent food value of rice.

Dr. Olcott: Actually we aren't spending much time on vitamins in our rice work, although we talk a lot about them.

Mr. Williams: (referring to Dr. Morgan's talk) Would enrichment of the protein in rice by varying cultural practices be of interest?

Mr. Creech: This is again emphasizing what it hasn't got. Improvement of keeping qualities is more important.

Dr. Altschul: Dr. Hopper of the SRRL concluded from analytical studies of rice with relation to soil and environment that there was not much probable benefit to be derived from changes in cultural practices.

Mr. Harris: I think it would be more profitable for Mr. Williams to give attention to added cooking and eating qualities.

Mr. Allyer: The selection of varieties should be more concerned with food value.

Mr. Fiske: This means chemical examination for oil, protein, etc.

Mr. Harris: Combined frozen products should be good subjects for investigation. Processes developed for cooking rice for freezing storage should be adaptable to other localities, and altitudes, and should take into account differences in water of different regions.

Mr. Leahy: You could get the help of other laboratories in studies of this kind. The problem of working out a uniform recipe for cooking rice is very great.

Dr. Copley: It really belongs to the Bureau of Human Nutrition and Home Economics.

Mr. Speh: If it's a question of preparing food in the home, it's a problem for the Bureau of Human Nutrition, but before the food reaches the home, it's our problem.

Miss Boggs: Perhaps we could contract with a high-altitude laboratory for studies in rice cooking under such conditions; for example, the one at Denver.

Mr. Diehl: Free advertising for frozen cooked rice could be obtained by the use of school demonstrations, by state nutrition groups.

Mr. Creech: Development of a satifactory quick-cooking rice would eliminate the risk of cooking rice in the home and getting an inferior product.

Mr. Fiske: How is frozen cooked rice prepared for serving?

Miss Boggs: We put it over boiling water for ten minutes and serve.

Mr. Allgyer then changed the subject to packaging problems.

Mr. Harris: The subject of packaging rice is one that needs further exploration.

Mr. Carter: At the Arkansas Cooperative we use cartons, untreated and moisture-proof cellophane bags, and kraft paper bags. Cellophane has the disadvantage of being difficult to fumigate, and it also rips and tears. Fumigation is better performed on rice in bulk storage.

Mr. Harris: Light causes some yellowing of rice in cellophane bags.

Dr. Olcott: I would like to take an informal poll of this group on rice curls. How many of you think they are good enough for the market? Would you pay out money for them? (Unanimous showing of hands)

Dr. Copley: I get an after taste from the sodium glutamate. I understand that a small percent of the population get this after taste.

Dr. Markley: What is the storage life of rice curls?

Dr. Kester: At our prevailing Berkeley temperatures, it is about three to four weeks.

Dr. Olcott: In keeping qualities, rice curls are about like other deep fat fried foods, such as potato and corn chips. How about the rice puffs? How many here would like to be able to buy them? (Good showing of hands but not unanimous approval. There was a short and relatively unimportant discussion following this, about the puffs.)

The discussion then turned to problems of storage and drying.

Mr. Brewer: Temperature of the rice seems to be more important than air temperature in drying. Warmer air is permissible for wet rice, but when the moisture drops to the 15-17 percent range, temperature must be lowered.

Mr. Jacob: At Davis drying studies on rice are being made with different designs of driers. Mr. Dobie is working with an infra-red drier. We have found that temperatures as high as 170°F. are allowable, if no moisture is removed, without loss of milling qualities. Rate of drying is probably the most important factor governing quality.

Mr. Harris: We need California data for California conditions.

Mr. Carter: It has been our experience that the temperature of the rice as it leaves the drier should not be much above atmospheric temperature. The moisture in the grain and the humidity of the air are most important considerations.

Mr. Jacob: An important consideration is heat transfer within the rice kernel.

Dr. Altschul and Mr. Harris both stated they believed that consultation on this subject between the areas would be very worth while.

Mr. Carter: Is there much being done with dielectric heating?

Dr. Altschul: Yes. There is a project on electronic drying at Baton Rouge.

Mr. Jacob: We are also doing some dielectric work at Davis in connection with rice drying.

Mr. Williams: There are two important problems in the handling and drying of seed rice. One is the proper treatment to preserve fertility. There is also the problem of maintaining pure strains in the bulk drying process.

Mr. Carter: In answer to Mr. Williams first point: This is not a solved problem. Some ways of preserving fertility are (1) to let the rice ripen in the field, then let it air dry and combine it, (2) aeration in the bin; that is, pull atmospheric air through it continuously until sufficiently dry. Aeration has three advantages: it may be used to hold the rice until the lot is assembled, or to prolong the between-drying period, or to cool the rice after drying.

Mr. Harris: I would like to see the Arkansas ventilation system tried on California rice.

Mr. Diehl: Has refrigerated air been used in rice drying? Is it of value?

Mr. Carter: This has not been tried to the best of my knowledge. Aeration of rice should be a natural for California.

Mr. Harris brought up the subject of rice spray-treated in the field to reduce moisture content.

Mr. Hoffman: The yield of head rice in treated fields showed a value increase of about 13 dollars per acre over the check.

Dr. Altschul: What is this material being used for spraying?

Dr. Kester: One sample we had sent to us and which is now being analyzed, was sprayed with sodium pentachlorophenate.

Mr. Harris: I understand the cost of this spray treatment is about four dollars and a half an acre.

Mr. Williams: We have plans for working on this subject at the station this year.

Mr. Deubner: Has there been any investigation of the effect of checking on germination of seed rice.

Mr. Tuttle: The rice seems to show no change in viability.

Mr. Carter: I don't believe there is a difference provided the grains remain unbroken. The problem is an agronomic one and should be left to the experiment stations.

Mr. Williams: There is still the question of proper storage and drying of seed rice to preserve the purity of strains.

Mr. Harris: The answer to that is governed by the premium that could be obtained for the pure strains. Will it compensate for extra handling costs?

The subject of rice-milling was then discussed.

Dr. Olcott: Mr. Carter, can you give us a little more detail about the steam treatment you use to improve milling quality?

Mr. Carter: We use a dual cylinder set-up. The rice enters the upper cylinder where steam is injected and penetrates the bran layer only. Then it goes into the lower cylinder where it meets an air blast that removes excess moisture. This treatment gives us greater huller capacity as less scouring is required; a higher yield results and less power is required. The increase is between 2 and 5 pounds per barrel.

The model rice mill at Stuttgart was discussed. Mr. Speh presented the status of the proposed contract between the Arkansas Experiment Station and the SRRL, and concluded his remarks by stating that this contract is now in the hands of the solicitor, and will most likely go through.

Mr. Creech then spoke for the rice industry in commending the various research organizations represented at the conference for their excellent work and enjoined the industrialists to support the research programs and the agencies involved with their active cooperation. Mr. Speh thanked him in reply and Dr. Copley concluded the meeting with an expression of gratitude to all who had participated. Meeting was adjourned at 4:30.

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